Biogeomorphic controls on barrier island evolution in response to climate change

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Rising relative sea level and potentially increasing storm activity will cause barrier islands to overwash more frequently, thus altering their stability in the future. Changes in plant species composition, such as the prevalence and distribution of dune-building grasses, are also expected as climate warms. Underlying these changes in physical and biological forcing is the potential for non-linear feedbacks between geomorphic and biological processes, associated with overwash and dune-building, to reinforce and expand the presence of overwash zones. Our objective is to investigate the existence of these biogeomorphic feedbacks and to assess how they might respond to changes in physical and biological forcing thereby affecting future island stability.

We have selected the undeveloped barrier islands of the Virginia Coast Reserve Long-term Ecological Research site (VCR-LTER) as our study area. This will allow us to investigate feedbacks within a natural barrier-island system, leaving complications due to development to future efforts. Though it is necessary to work initially within a narrow geographic region (i.e., Virginia) to investigate non-linear feedback mechanisms between geomorphic and biological processes, our results will be applicable to other barrier islands throughout the world where both dune-building grasses and laterally-propagating species are present.

Specific questions we will address include: 1) How do morphological zones and plant species composition co-vary? 2) Are overwash and dune areas persistent through time and can this be tied to species composition? 3) What is the current status of barrier island vulnerability to storm impacts, how is this different from a decade ago and is there a relationship with changes in species composition?, 4) How do changes in vulnerability compare to those we would expect given shifts in physical and biological forcing alone?, and 5) Given current topography and species composition, potential feedbacks, and a range of anticipated changes in physical and biological forcing, what are likely barrier island responses in the future?

A collaborative team will employ a combination of remote sensing, field observation and analytical modeling approaches to address the questions outlined above. These approaches will include: 1) using lidar data, hyperspectral imagery and field surveys to assess the dominance of species in morphologcal zones and to assess the potential for conversion of overwash to dune, 2) using historical aerial photograpy, ground penetrating radar and sediment coring to determine temporal persistence of dune and overwash zones, 3) applying topographic change analysis to determine changes in island vulnerability through time, 4) comparing actual changes in vulnerability with estimated changes due to climate forcings alone, and 5) developing an analytical model to assess how non-linear feedbacks might alter the range of island responses to climate change, therefore affecting future stability.

The improved understanding of non-linear biogeomorphic feedbacks will improve assessments of barrier island response to climate change. Specific project outcomes, including written descriptions of project results, maps of morphological zones and species composition, and maps of current and future island vulnerability, will be presented at national society meetings, in journal publications and made publicly available on the LTER web site within 12 months of project completion. Results will also be incorporated into a summer workshop for teacher recertification developed through the VCU School of Education.